RAILROADS

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RAILROAD REVIEW

Railroads present additional administrative and engineering problems, Any work adjacent to or over a railroad track, must be approved by the railroad concerned. The first step is review and approval of the Contractor% shoring plans; this must be donebefore any work can start at the jobsite. The Office of Structure Construction is the liason between the job and the railroad. The review and approval procedure is the same as it is for falsework plans. The Resident' Engineer or Bridge Representative submits the Contractor% shoring plans to the Sacramento Office of Structure Construction. A supplemental review is performed by the Office of Structure Construction in Sacramento and the shoring plans are transmitted to-therailroad for their review. The railroad replies to OSC Sacramento, which in turn will inform the Resident Engineer who approves to the Contractor. It is important that this procedure is followed strictly in order that we get approval in minimum time from the railroad. For normal shoring projects, the average railroad review time is about 6 weeks. It is important that plans are prepared and include additional features that railroads require such as noted clearances, horizontal and vertical.

Section 194.02, "Preservation of Property" of the Standard Specifications includes a provision stipulating that shoring plans be submitted at least 8 weeks before the Contractor intends to begin any excavation requiring shoring.

Most business is with the major railroads, Southern Pacific Transportation Co. (SPTC), Union Pacific System (UP), and the Atchison, Topeka & Santa Fe Railway Co (AT&SF). The SPTC have Supplemental Specifications to Part 20 of Chapter 8 of the AREA Manual for Railway Engineering in regard to shoring. These have been in effect since 12-12-75. All of the major railroads have agreed to accept that SPTC Specifications for review of shoring systems. For lesser railroads, such as *Sierra Railroad', use the SPTC Supplemental Specification unless there are specific instructions from the railroad concerned. A complete cow of the Supplemental Specifications is in Appendix C of this manual.

Limiting lines for no shoring required and trainmen walkway requirements are different for the AT&SF Railway- See sheet depicting slopes entitled 'Requirements for Excavation Shoring - The Atchison Topeka, and Santa Fe Railway Company' in this section. Exceptions can be made by the railroads.

The following is a summary of the SPTC Supplemental Specifications to Part 20 of Chapter 8 of AREA Manual for Railway Engineering:

1.1 This section establishes the minimum horizontal distance. that any part of a shoring system can be from center of the track, 8'-6" on tangents. To obtain a waiver of this requirement would require a very unusual situation.

1.2 This section restricts the type of shoring that can be used. Between 8'-6" and 10' from center of track (13' if excavation is in fill ground other than compaction controlled fill), the shoring must be a of a type that precludes the possibility of disturbance or loss of soil or base supporting the track. This means that progressive lagging (soldier beam) cannot be used; driven sheet piles or concrete walls with struts placed as excavation develops would be acceptable. The sheet piles or concrete wall would have to be placed between train movements, or during temporary shut-down of track.

1.4 Requirements for handrails. A walkway and standard handrail is required within 13' of centerline of track. This is for normal access of trainmen to track, not the protection of trench excavation as required by DOSH. Such walks and handrails are to be shown on the shoring plans.

2.1 Soil classification. The soil classification is to be shown on the plans. An equivalent classification to the AREA System is acceptable. Include groundwater conditions anticipated.

3.1
to
3.7 These sections pertain to minimum loads on earth retaining systems. Note that the railroad exempts strutted trenches -the earth pressure for such will be the minimums as required by DOSH or by calculation, using actual soil parameters; this procedure is discussed elsewhere in the manual. For flexible systems, such as cantilevered walls, use the minimum equivalent fluid pressure of 36 pcf, or the pressures calculated from actual soil properties. An exception to AREA is the railroad live load surcharge. SPTC has developed an empirical curve in lieu of the Boussinesq curve defined by AREA (CHART 3.6). This live load surchargecurve will be used for all earth retaining systems (Section 4.1 as well as 3.1). restrained or flexible.

5.   Section 5 deals with the allowable unit stresses and factors
      of safety. There are some differences from the policy given
      in this manual, however they are minor. Use controlling
      railroad allowable stresses when a railroad is involved.

6.1   This section pertains to the preparation of the shoring
      plans. A good clear well-engineered plan is the best way
      to get an early approval from the railroad. Be sure at
      pertinent minimum clearance dimensions are included.
      Railroads require that the shoring plan be prepared by a pro-
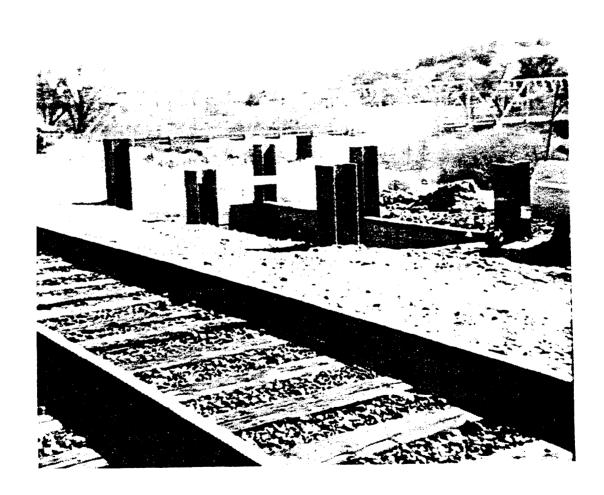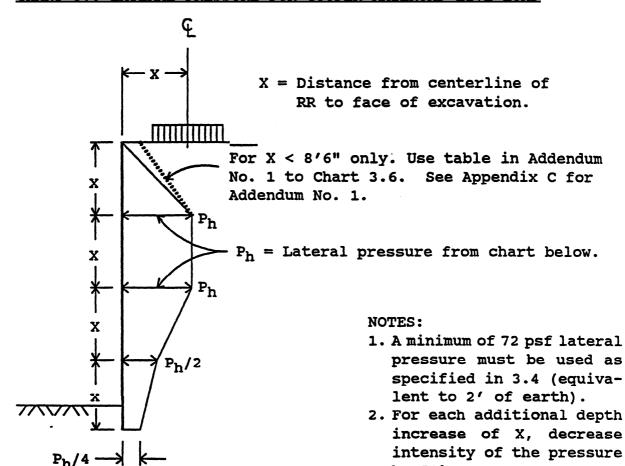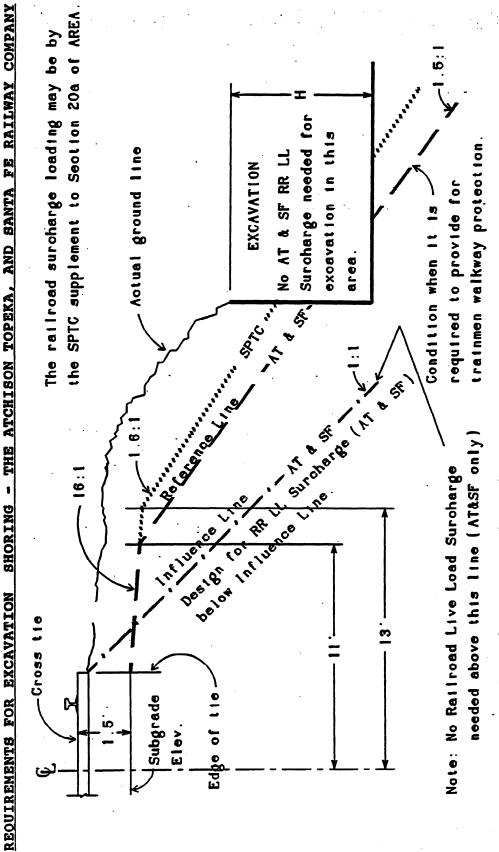   fessional engineer.

CHART 3.6 LATERAL PRESSURE FOR COOPER RAILROAD LIVE LOAD

X = Distance from centerline of
RR to face of excavation.

For X < 8'6" only. Use table in Addendum
No. 1 to Chart 3.6. See Appendix C for
Addendum No. 1.

P_h = Lateral pressure from chart below.
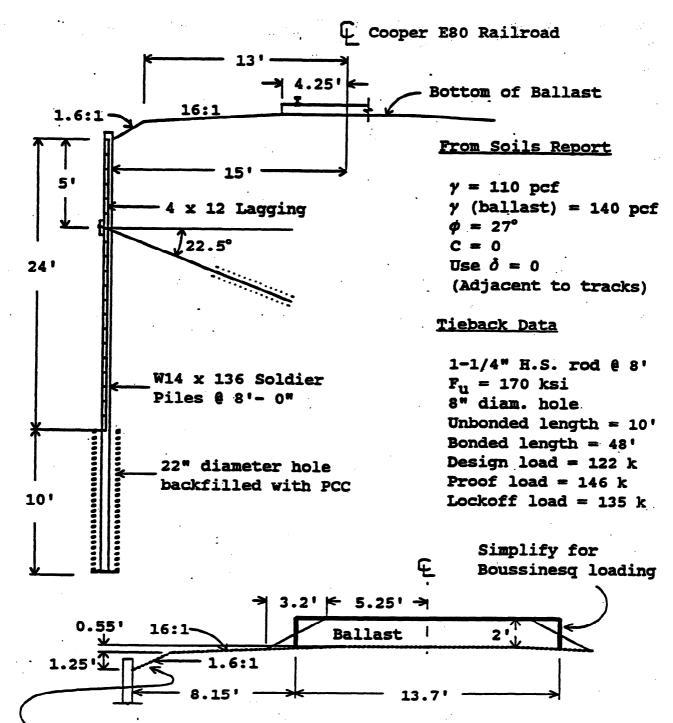
NOTES:
1. A minimum of 72 psf lateral pressure must be used as specified in 3.4 (equivalent to 2' of earth).
2. For each additional depth increase of X, decrease intensity of the pressure by 50%.

See Addendum No. 1
to Chart 3.6, Appendix C

P_h
(psf)

500
400
300
200
100

COOPER E80

72

5   10   15   20   25   30

X (Ft)

REQUIREMENTS FOR EXCAVATION SHORING - THE ATCHISON TOPEKA, AND SANTA FE RAILWAY COMPANY

The railroad surcharge loading may be by the SPTC supplement to Section 20a of AREA.

Actual ground line

EXCAVATION

No AT & SF RR LL Surcharge needed for excavation in this area.

H

1.5:1

16:1

1.5:1

Reference Line ········ SPTC

— AT & SF

Influence Line — · — AT & SF

Design for RR LL Surcharge (AT & SF) below Influence Line.

1:1

Condition when it is required to provide for trainmen walkway protection.

Cross tie

1.5

Subgrade Elev.

Edge of tie

11'

13'

Note: No Railroad Live Load Surcharge needed above this line (AT&SF only)

Generally no shoring will be required if the bottom of excavation is above a railroad reference line and the ground will stand on it's own. Also, for a trench condition where H > 5', shoring is required per Cal-OSHA. The dotted line shows reference line for SPTC (Rev 8-30-74). The SPTC criteria applies to UPRR, WPRR, NWP, SD & AE. Railroads should be notified prior to start of work. Railroad approval will be required for any work within 15'- 0" of the center line of track. Shoring that intersects the AT & SF Influence Line must be designed to withstand railroad live load lateral forces. The Influence Line is not to be used for unsupported slope excavations.

Revised (06/95)

SAMPLE PROBLEM NO. 9 - SOLDIER PILE WITH RAILROAD SURCHARGE

$\mathbb{C}$ Cooper E80 Railroad

Bottom of Ballast

From Soils Report

γ = 110 pcf
γ (ballast) = 140 pcf
ϕ = 27°
C = 0
Use δ = 0
(Adjacent to tracks)

16:1

1.6:1

13'

4.25'

15'

5'

4 x 12 Lagging

22.5°

24'

Tieback Data

1-1/4" H.S. rod @ 8'
F_u = 170 ksi
8" diam. hole
Unbonded length = 10'
Bonded length = 48'
Design load = 122 k
Proof load = 146 k
Lockoff load = 135 k

W14 x 136 Soldier
Piles @ 8'- 0"

22" diameter hole
backfilled with PCC

10'

Simplify for
Boussinesq loading

$\mathbb{C}$

3.2' 5.25'

0.55'   16:1

Ballast   2'

1.25'

1.6:1

8.15'   13.7'

Slope line from Southern Pacific Transportation Company Engi-
neering Common Standard Drawing No. C.S.582, dated August 30, 1984
(see previous page). Adequate shoring will be required for
excavations below this line.

If the soil parameters have been determined from a qualified soil analysis, the values for ϕ & C must be reduced by 15%. This allows for the dynamic effects of train loadings on the retained material. If soil parameters have not been furnished, then the following minimum values must be used. These values are from the AREA Manual:
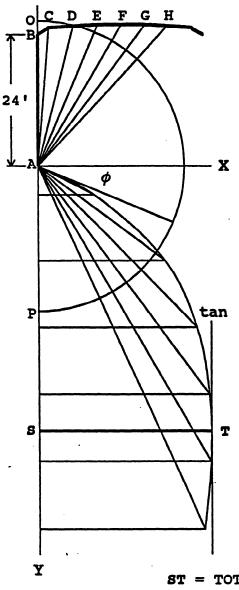
$$Kw = 36 \text{ pcf}$$
$$\gamma = 110 \text{ pcf}$$
$$\phi = 30°$$

Since a soils report was furnished, the values from the report will be used. Reduce ϕ by 15%. $(27°)(0.85) \approx 23°$

DETERMINE LATERAL SOIL PRESSURES (Use the Trial Wedge method)

Known:
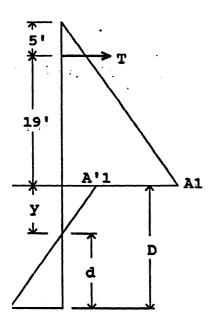
$$\phi = 23°$$
$$\gamma = 110 \text{ pcf}$$
$$\delta = 0$$
$$H = 24'$$

WEDGE WEIGHT CALCULATIONS:

ABC = (110)(24.0) = 2,640 Lb/LF
ACD = (110)(55.0) = 6,050 Lb/LF
ADE = (110)(54.9) = 6,039 Lb/LF
AEF = (110)(55.0) = 6,050 Lb/LF
AFG = (110)(55.9) = 6,149 Lb/LF
AGH = (110)(55.8) = 6,138 Lb/LF

TOTAL: 33,066Lb/LF

ST = TOTAL LATERAL PRESSURE (P) = 15,700 Lb/LF

$P_{A1} = 2P/H = (2)(15,700)/24 = 1,308$ psf

Not a level surface, therefore cannot use standard equation or charts for K_a. Use:
$K_a \approx P_A/\gamma H \approx 1308/(110)(24) \approx 0.50$

For a level surface:
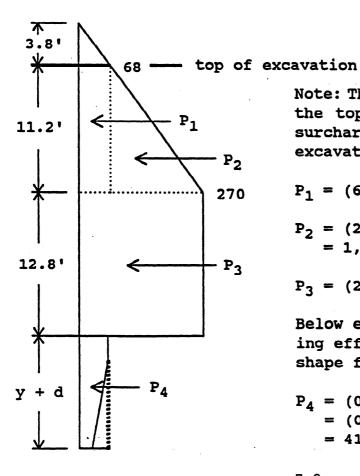$$K_p = \tan^2(45° + \phi/2)$$
$$= \tan^2(45° + 23/2) = 2.28$$

Arching capability = 1.0
$f = (22/12)(1.0)/8 = 0.23$

$P_{A'1} = fP_{A1} = (0.23)(1,308) = 300.8$ psf

$= P_{A'1}/f\gamma(K_p - K_a) = 300.8/(0.23)(110)(2.28 - 0.50) = 6.68'$

$\vdots = f\gamma(K_p - K_a)d = (0.23)(110)(2.28 - 0.50)d = 45.0d$

ilroad surcharge

68 —— top of excavation

Note: The pressure diagram begins at the top of the ballast. Only the surcharge pressure below the top of excavation is used.

$P_1 = (68)(11.2) = 762$ Lb/LF
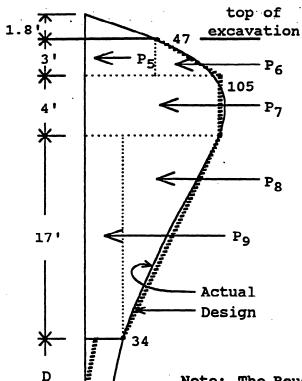
$P_2 = (270 - 68)(11.2)/2$
$\quad = 1,131$ Lb/LF

$P_3 = (270)(12.8) = 3,456$ Lb/LF

Below excavation: Consider arching effect. Assume rectangular shape for simplicity.

$P_4 = (0.23)(270)(y + d)$
$\quad = (0.23)(270)(6.68 + d)$
$\quad = 414.8 + 62.1d$ Lb/LF

BALLAST SURCHARGE

$P_5 = (47)(3) = 141$ Lb/LF

$P_6 = (105 - 47)(3)/2$
$\quad = 87$ Lb/LF

$P_7 = (105)(4) = 420$ Lb/LF

$P_8 = (105 - 34)(17)/2$
$\quad = 604$ Lb/LF

$P_9 = (34)(17) = 578$ Lb/LF

Below excavation:
 Consider arching effect.
 $(34)(0.23) = 7.8$ psf (neglect)

Note: The Boussinesq pressure diagram begins at the bottom of the ballast. Only the surcharge pressure below the top of excavation is used. The equivalent soil height method could have been used for the ballast in lieu of the Boussinesq surcharge method.

DETERMINE D

$\Sigma M_T = 0$

Moment due to surcharge:

$(414.8 + 62.1d)[19 + (6.68 + d)/2] + 762[11.2/2 - 5]$
$+ 1,131[(11.2)(2/3) - 5] + 3,456[(12.8/2) + 6.2]$
$- 141[3/2 + 2] - 87[3/3 + 2] + 420[0] + 604[17/3 + 2]$
$+ 578[17/2 + 2$

$M_{surch} = 31.1d^2 + 1,594.7d + 66,004.4$ Ft-Lb/LF

Moment due to soil:

$15,700[(24)(2/3) - 5] + \{(300.8)(6.68)/2\}[6.68/3 + 19]$
$- \{(45.0d)(d)/2\}[19 + 6.68 + (2/3)(d)]$

$M_{soil} = -15d^3 - 577.8d^2 + 194,025.8$ Ft-Lb/LF

Combined moment = $-15d^3 - 546.7d^2 + 1,594.7d + 260,030.2 = 0$
or $= d^3 + 36.4d^2 - 106.3d - 17,335.3 = 0$

By trial and error $d = 18.72'$ $\therefore D = d + y = 18.72 + 6.68 = 25.4'$

A low passive arching capability results in a high D value. For this example, an alternate design would be more practical. The remainder of this problem is not presented.